2 INTRODUCTION AND OVERVIEW

From July 1, 1997 to July 1, 1998,Vermont phased in the implementation of a residential energy conservation code (RBES). The RBES code affords builders and architects design flexibility by allowing trade-offs between different building components, and between the building envelope and heating equipment efficiencies. The code was set at a level of energy efficiency significantly higher than the baseline practices established by the 1995 study of residential new homes. This study was designed to assess current baseline construction practices and compare them to the RBES code requirements. It was also designed to determine the saturation of high efficiency appliances and equipment.

Another factor impacting the energy efficiency of new homes in Vermont is the efficiency programs operated in the state over the last decade, starting with the utility programs in the early 1990's and continuing with the statewide programs implemented by Efficiency Vermont since 2000. In addition to programs specifically targeted at residential new construction, other programs designed to affect the appliance and lighting markets may also have an impact on new homes.

This report presents the baseline construction practices in new, single family homes in Vermont and compliance levels with the RBES code. Beyond the building envelope and heating systems, this study also assesses the saturation of energy efficient lighting and appliances in these new homes. The study was conducted by West Hill Energy and Computing, Inc. on behalf of the Vermont Department of Public Service with assistance from Xenergy, who provided assistance with developing the sampling plan and soliciting participants for the on site study.

The results of the study show improvement in home construction with respect to energy efficiency and code compliance as compared to the previous study in 1995.

2.1 PURPOSE AND OBJECTIVES

The overall purpose of this study was to determine baseline construction practices of newly constructed homes following the implementation of the RBES code, and to assess the efficiency of lighting and common appliances being installed in these homes. Although this study was not intended to be an exhaustive impact analysis of the efficiency program impacts on construction decisions and appliance purchases, some aspects of home building and appliance purchases are likely to be affected by the utility DSM programs of the late 1990's and the ongoing efficiency programs currently implemented by Efficiency Vermont, and this study will highlight the effects of these efficiency activities, as appropriate.

This study was accomplished through the following four strategies:

1. Determine current construction practices based on nearly 160 onsite surveys of newly constructed houses.
2. Assess the level of code compliance based on the onsite survey data and investigate the reasons for noncompliance.
3. Measure the saturation levels of efficient lighting and appliances.
4. Compare current construction practices to construction practices prior to the RBES code.

2.2 STUDY COMPONENTS

Three sources of data and information were employed to fulfill this study's objectives. The primary source of data came from the detailed, on-site reviews of the construction characteristics of 158 new homes in Vermont. This process included compiling detailed building characteristics data from an on site survey of each house in our sample. Two other sources were used for comparison and context: these were the study of baseline construction practices from site visits conducted in 1995 (prior to the RBES code) and Xenergy's recent telephone surveys of owners and builders of new homes in Vermont. Seventy-six of the 158 on site participants were recruited from these phone survey participants. A by-product of the nested sampling approach was the ability to compare the responses from the telephone surveys to the verified, on site data for a few key data points.

2.3 STUDY APPROACH

The details of our approach are discussed in subsequent sections of this report. Here we provide an overview of the approach.

The construction data collected via the onsite surveys provided the key inputs to several analyses. First, the data allowed us to document current construction practices for a numerous characteristics related to energy efficiency including window area, window type, envelope insulation levels, floor area, natural infiltration rates, etc. Second, the data were used to determine whether each home surveyed actually met the efficiency requirements of the new code. Based on these data, we were able to determine if each home complied with the code and the overall compliance level. Third, these data allowed us to explore what factors were responsible for noncompliance in homes that did not comply. The onsite survey data also permitted us to analyze specific issues related to common building practices. Two key issues of interest were the sizing of heating equipment and the saturation and efficiency levels of manufactured housing. Finally, we were able to establish the saturation of efficient appliances and lighting in these new homes.

Comparison of the results of the new on site survey to the previous baseline survey of homes built in 1993 and 1994 provides a general sense of the movement of the market over the past seven years, keeping in mind that the two studies were not designed to be longitudinal. Xenergy's telephone surveys of homeowners and builders provides context to the on site surveys, and illuminates areas of potential discrepancies to be resolved in further studies.

Finally, a by-product of the overlapping samples was the opportunity to compare phone responses to documented, on-site data for about half of the 158 survey participants. This comparison allowed us to verify homeowners' responses to a few key questions and to investigate the possibility of significant variations between the telephone and on site samples.

2.4 REPORT CONTENTS

This report presents study findings at three different levels of detail. Section 1, the Executive Summary, briefly discusses the approach and highlights the key findings and recommendations. Sections 2 through 10 present more comprehensive information on how the study was conducted and highlights the findings on topics that were identified as being of primary interest. The appendixes are included to provide more detailed information about specific findings from the on site surveys.

Section 3 describes the steps taken to design a sample and the data collection process. Section 4 describes how we analyzed the current practice construction data to characterize current construction practices and assess code compliance.

Section 5 covers the findings on general house characteristics, including house size, participation in efficiency programs, construction types, owner-built and manufactured homes, and municipal water and sewer hook ups. Section 6 contains the results on RBES code compliance and construction practices related to ventilation and thermal shell characteristics. In Section 7, equipment and fuel choices for space heating and water heating are documented. Lighting and appliance efficiency and fuel choice is discussed in Section 8, and the comparison of responses between the telephone and on site surveys for the 76 homeowners who participated in both studies is explored in Section 9. Findings and recommendations can be found in Section 10.